2019

NORTH SHORE OF LAKE SUPERIOR
REMEDIAL ACTION PLANS

THUNDER BAY AREA OF CONCERN

BEACH CLOSINGS
BENEFICIAL USE IMPAIRMENT

Status Report

Sandy Beach on Thunder Bay, Ontario (Jim Bailey, 2014)

ACKNOWLEDGEMENTS

This *Beach Closings Beneficial Use Impairment Status Report for the Thunder Bay Area of Concern* is an update to the previous, 2016 version. The 2016, and the subsequent 2019 versions were prepared, reviewed and edited by members of the Remedial Action Plan Steering Committee:

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The Remedial Action Plan Steering Committee would like to thank the *Thunder Bay District Health Unit* for providing monitoring data from Chippewa Main, Chippewa Sandy and Boulevard Main beaches, and for providing subject matter expertise.

EXECUTIVE SUMMARY

This report does not provide a formal assessment of the Beach Closings beneficial use impairment (BUI) within the Thunder Bay Area of Concern (AOC), but rather an update on the current status when measured against the new Ontario-wide recreational water quality guideline. Effective January 2018 under the Recreational Water Protocol (MOHLTC, 2018a), the Ontario Ministry of Health and Long-Term Care (MOHLTC) changed the provincial guideline for recreational water use at public beaches from a geometric mean of **≤100** *E.coli* per 100mL to **≤200** *E.coli*/100mL (MOHLTC, 2018a).[1] Using information provided by the Thunder Bay District Health Unit (TBDHU), this report provides an assessment of monitoring data going back several years (2005 to 2018) measured against this new guideline, and also summarizes the remedial actions undertaken since the mid 1990s to address the Beach Closings impairment in the AOC.

To help guide remedial actions and direct monitoring efforts, in 2013 the Thunder Bay Remedial Action Plan Implementation Committee and the Public Advisory Committee developed the following delisting criteria for the Beach Closings BUI:

> *1) All public beaches have identified primary sources of fecal pollution and pollution control plans have been developed and implemented, including:*
> - *Management of stormwater inputs*
> - *Upgrades of septic systems to provincial standards*
> - *Implementation of a management program for birds and animals*
> - *A completion of feasible actions to improve water circulation*
>
> *2) Water quality testing carried out at all public beaches on a regular, frequent and ongoing basis demonstrates that 80% of geometric means have E.coli counts of **100** or less colony forming units per 100mL of water (**≤100** E.coli/100mL) (MOE, 1994) based on a five year monitoring average (PAC, 2013).*

When developed in 2013, delisting criterion #2 was linked to and consistent with the government guideline established for recreational water quality for all of Ontario. The guideline at the time was an *E.coli* count of ≤100 *E.coli*/100mL of water; adopted directly from the Provincial Water Quality Objectives set by the Ministry of the Environment, Conservation and Parks in the early 1990s, which was based on the recreational water quality guideline published by the Ministry of Health and Long-Term Care in 1992 (MECP, 2018). With the change in the MOHLTC guideline effective January 2018, delisting criterion #2 has been revised to remain linked to and consistent with the government guideline established for recreational water quality for all of Ontario, and therefore reads:

> 2) *Water quality testing carried out at all public beaches on a regular, frequent and ongoing basis demonstrates that 80% of geometric means have E.coli counts of **200** or less*

[1] The symbol ≤ means less than or equal to.

*colony forming units per 100mL of water (**≤200** E.coli/100mL) (MOHLTC, 2018b) based on a five year monitoring average.*

This status report is the mechanism by which the above revised wording for delisting criterion #2 is recognized and communicated to reflect the revisions made in MOHLTC's recreational water quality guideline in January 2018.

It should be noted the revised Ontario-wide guideline and delisting criterion #2 are consistent with the Canada-wide guideline set for the whole country by Health Canada (Health Canada, 2012), which also calls for a geometric mean concentration of ≤ 200 E. coli/100 mL for fresh waters used for swimming and recreational activity.

Assessed against the revised delisting criterion #2, monitoring data indicates that water quality at Boulevard Main Beach meets the delisting criterion 91% of the time and Chippewa Sandy Beach meets the delisting criterion 94% of the time, with Chippewa Main Beach showing a trend toward meeting the criterion but falling just short by meeting it 79% of the time.

With respect to delisting criterion #1, fecal pollution from wildlife, not humans, was found to be contributing to the bacterial contamination at Chippewa Park and Boulevard Lake beaches, and a number of remedial actions have been implemented since the mid-1990s in an effort to reduce this as well as other types of pollution.

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INTRODUCTION

Thunder Bay Area of Concern

Thunder Bay is one of the 43 Great Lakes Areas of Concern (AOCs) as identified by Canada and the United States pursuant to the Great Lakes Water Quality Agreement (GLWQA, 2012). AOCs are locations in which the environment has been impaired by human activities at the local level, and may include significant chemical, physical, and biological degradation, including impacts from water pollution, contaminated sediment, and impacts to habitat.

Thunder Bay was designated an AOC due to the impacts of urbanization along the waterfront, industrial and municipal wastewater discharge, contaminated sediment, and hydroelectric development along its urban tributaries. The AOC extends 28 kilometres along the shoreline of Lake Superior and up to 9 kilometres offshore, including the Welcome Islands. Most environmental impacts are concentrated around the urbanized and industrialized area of the waterfront and tributaries (Figure 1).

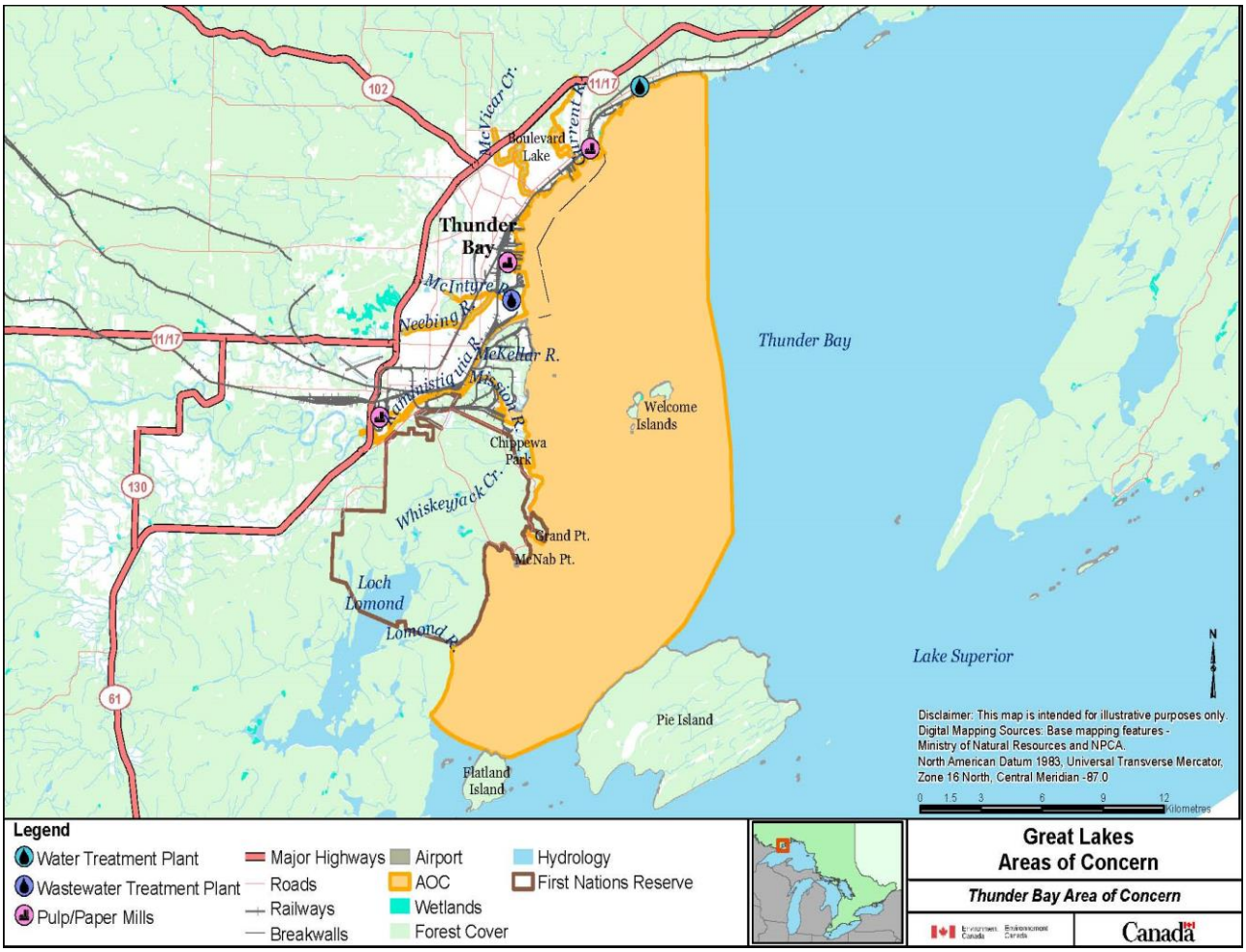

Figure 1: Thunder Bay Area of Concern

The governments of Canada and Ontario work together to restore AOCs. This work relies on collaboration with conservation authorities, municipalities, First Nation and Métis communities, environmental groups, industry and the public. Working together, communities and governments develop a Remedial Action Plan (RAP) that defines and identifies environmental problems, known as beneficial use impairments, and establishes remedial and monitoring actions to address them.

Beach Closings Beneficial Use Impairment

In 1991, the Stage 1 RAP report (Thunder Bay Remedial Action Plan, 1991) identified the status of fourteen beneficial use impairments (BUIs) as "impaired", "not impaired", or "requires further assessment" in the Thunder Bay Area of Concern. BUIs are caused by reductions in the chemical, physical or biological integrity of the waters of the Great Lakes. Out of the possible fourteen BUIs, eleven BUIs were identified in the Thunder Bay AOC as being "impaired" or "requires further assessment" in the Stage 1 RAP report released in 1991. The Beach Closings BUI was deemed “impaired”.

Dating back to the 1980s, elevated levels of bacterial contamination caused frequent beach closures at Chippewa Park and Boulevard Lake beaches during the summer months, thereby affecting recreational use of the waterways. Concentrations of fecal coliforms were often in excess of the Ontario Ministry of the Environment, Conservation and Park’s Provincial Water Quality Objectives (which were consistent with the Ministry of Health and Long Term Care’s Recreational Water Quality Guideline at the time), and therefore, Beach Closings was designated as “impaired” in the Thunder Bay AOC in the Stage 1 RAP report (Thunder Bay Remedial Action Plan, 1991), and remained “impaired” in the Stage 2 RAP report (Vander Wal et al., 2004), and subsequent RAP Update report (Nicholson, 2012).

Around the time when Thunder Bay was designated an AOC, the Stage 1 RAP report stated that the majority of the fecal coliform bacteria sampled at Chippewa Park were *E.coli* (Thunder Bay Remedial Action Plan, 1991). Several studies investigated the sources of contamination at the beaches from 1986-2001, and are presented in the literature review appended to this report (Appendix A). Transient waterfowl such as geese, ducks and gulls and stormwater discharges were identified as the primary sources of elevated bacterial levels at the beaches. Boulevard Lake beaches were also found to have bacterial contamination, however; the Thunder Bay *Pollution Prevention and Control Plan* study determined that stormwater outlets into the lake were not a significant source of bacteria to this water body (Vander Wal et al., 2004). Therefore, there was no cause for concern expressed by the Thunder Bay District Health Unit (TBDHU) for further action at Boulevard Lake other than routine monitoring at the time of the Stage 1 RAP report.

Routine monitoring of bacterial levels at Chippewa Park and Boulevard Lake beaches has and continues to be implemented by TBDHU (with the exception of Sandy Cove Beach and

Sunnyside Beach – refer to the "Monitoring Scope" section below). The results from the monitoring efforts are included in this report.

Remedial actions intended to reduce the source and risk of bacterial contamination at beaches are also included in this report and are further detailed in the appended reports (Appendix B), including: upgrades to washroom fixtures, installation of new septic systems, improved drainage system, and partial removal of the breakwall at Chippewa Park beaches.

Recreational Water Protocol

The Recreational Water Protocol, established by the Ontario Ministry of Health and Long Term Care (MOHLTC) under the authority of the *Health Protection and Promotion Act*, assists local health units in the prevention and reduction of water-borne illness and injury related to recreational water use (MOHLTC, 2018a). The Protocol was updated in 2018 and includes the following definition of a public beach:

Any public bathing area owned/operated by a municipality to which the general public has access, and where there is reason to believe that there is recreational use of the water (e.g., beach signage, sectioned off swimming area, water safety/rescue equipment, lifeguard chairs, etc.), which may result in waterborne illness or injury as determined by the local medical officer of health (MOHLTC, 2018b).

Recreational water quality is influenced by various environmental and anthropogenic factors, including recent rainfall and intensity, wind speed and direction, wave action, water and ambient air temperatures, weather conditions (e.g. cloudy, sunny), waterfowl, municipal and industrial wastewater, stormwater, septic system discharges, and agricultural run-off.

Postings, or communication notices made by the local health unit (TBDHU in this case), are posted for public beaches. These are often referred to as *beach advisories*. An advisory or posting does not close a beach, but is used to inform the public about potential risks to health and safety based on the amount of time the water contained "adverse" levels of *E.coli*. This precautionary approach allows the public to take protective measures. The advisory is reported as a percentage, which is based on data collected over the previous five years, and is reflective of the probability of encountering high levels of *E.coli* on any given day.

What is Escherichia coli (E.coli) Bacteria?

"*E.coli* is a species of fecal coliform bacteria which indicates the presence of human or animal wastes within recreational waters. Microbes within these wastes have the potential to cause human health risk through consumption or contact" (Ontario Public Health, 2008).

Beach closures are rare and ordered under Section 13 of the *Health Protection and Promotion Act, 1990* when conditions present a serious and immediate health risk for bathers. TBDHU has not issued any closures at the public beaches they monitor since 2003. Potential adverse events that may warrant a closure include:

- Chemical, oil, sewage, or other waste spill
- Waste water treatment plant by-pass
- Blue-green algae bloom
- Fish die-off
- Visible debris, metal, or sharp objects in the water or beach area.

Delisting Criteria for Beach Closings BUI

The Great Lakes Areas of Concern program requires a means to evaluate BUIs that are identified for a particular AOC. This is done through the development of delisting criteria, which are AOC-specific restoration targets and the measure against which a BUI is deemed "impaired" or not. To be effective, they should be linked to conditions at a non-AOC reference site, a government guideline or standard, or a locally-defined target such as an improving trend.

The delisting criteria for the Beach Closings BUI, developed by the Thunder Bay RAP Implementation Committee in conjunction with the Public Advisory Committee was:

> *1) All public beaches have identified primary sources of fecal pollution and pollution control plans have been developed and implemented, including:*
>
> - *Management of stormwater inputs*
> - *Upgrades of septic systems to provincial standards*
> - *Implementation of a management program for birds and animals*
> - *A completion of feasible actions to improve water circulation*
>
> *2) Water quality testing carried out at all public beaches on a regular, frequent and ongoing basis demonstrates that 80% of geometric means have E.coli counts of **100** or less colony forming units per 100mL of water (MOE, 1994) based on a five year monitoring average (PAC, 2013).*

When developed in 2013, delisting criterion #2 established the *E.coli* count of ≤100 *E.coli*/100mL of water, which was adopted directly from government guidelines in place at the time: the Ministry of Health and Long-Term Care's (MOHLTC) recreational water quality guideline and the Ministry of the Environment, Conservation and Parks' (MECP) Provincial Water Quality Objectives which was based on MOHLTC's recreational water quality guideline (MECP, 2018). Effective January 1, 2018, the MOHLTC provincial guideline for recreational water use at public beaches was revised from a geometric mean of **≤100** *E.coli* per 100mL to **≤200** *E.coli per* 100mL (MOHLTC, 2018b).

Therefore, with the change in the MOHLTC guideline, delisting criterion #2 has been revised to remain linked to and consistent with what the Government of Ontario has established for recreational water quality for all of Ontario. It is worth noting that MOHLTC's revised guideline for recreational water use is now the same as the Canada-wide guideline (Health Canada, 2012).

To reflect the MOHLTC guideline changes effective January 2018, delisting criterion #2 has been revised to:

> *2) Water quality testing carried out at all public beaches on a regular, frequent and ongoing basis demonstrates that 80% of geometric means have E.coli counts of **200** or less colony forming units per 100mL of water (**≤200** E.coli/100mL) (MOHLTC, 2018b) based on a five year monitoring average.*

This status report is the mechanism by which the above revised wording for delisting criterion #2 is recognized and communicated to reflect the revisions made in MOHLTC's recreational water quality guideline in January 2018.

The MOHLTC guideline evaluates *E.coli* levels collected from recreational waters using a geometric mean. A geometric mean is different from an arithmetic mean in that it more accurately represents continuous data series, thereby allowing for more meaningful statistical evaluations of bacterial levels at the beaches. An arithmetic mean, or the "average", is calculated by dividing the sum of a series of numbers by the count of that series of numbers. A geometric mean on the other hand is calculated by multiplying the numbers in a series, and then taking the root of the total count of that series. The formula to calculate a geometric mean is:

Geometric Mean = ((X1)(X2)(X3).....(Xn))1/n

where X1, X2, etc. represent the individual data points and n is the total number of data points used in the calculation (MOHLTC, 2018b).

TBDHU collects and uses a minimum of five samples when calculating the geometric means of *E.coli* counts from Chippewa Park and Boulevard Lake beaches. The use of five samples allows for a better representation of the uneven distribution of bacteria within the water bodies.

The qualifier of "80% of geometric means" is based on the Canadian Blue Flag water quality criteria for freshwater beaches, which states that "in order to qualify for a Blue Flag, at least 80 per cent of your geometric mean results must fall below the limit value" (Environmental Defense, 2014). The limit value (i.e. counts of *E.coli*) is set at the local level and consequently varies between cities, provinces and countries. Therefore, this second component of the Beach Closings delisting criterion pertaining to the presence of *E.coli* in recreational waters was linked directly to the official government guidelines set at that time across Ontario. This was part the Thunder Bay AOC-specific restoration target set to measure whether the Beach Closings BUI is deemed "impaired" or not.

This report presents a separate discussion on both of the delisting criterion. Criterion #1 is discussed in the "Completed Actions" section, and criterion #2 is discussed in the "Monitoring Data – Results" section.

THUNDER BAY BEACHES

Historically, five beach locations in Thunder Bay have been assessed through the Areas of Concern program: two in Chippewa Park (Chippewa Main and Chippewa Sandy), which is on the shores of Lake Superior; and three at Boulevard Lake (Boulevard Main, Boulevard Sandy Cove and Boulevard Sunnyside), which is not on Lake Superior but instead receives water from the Current River – Figure 2.

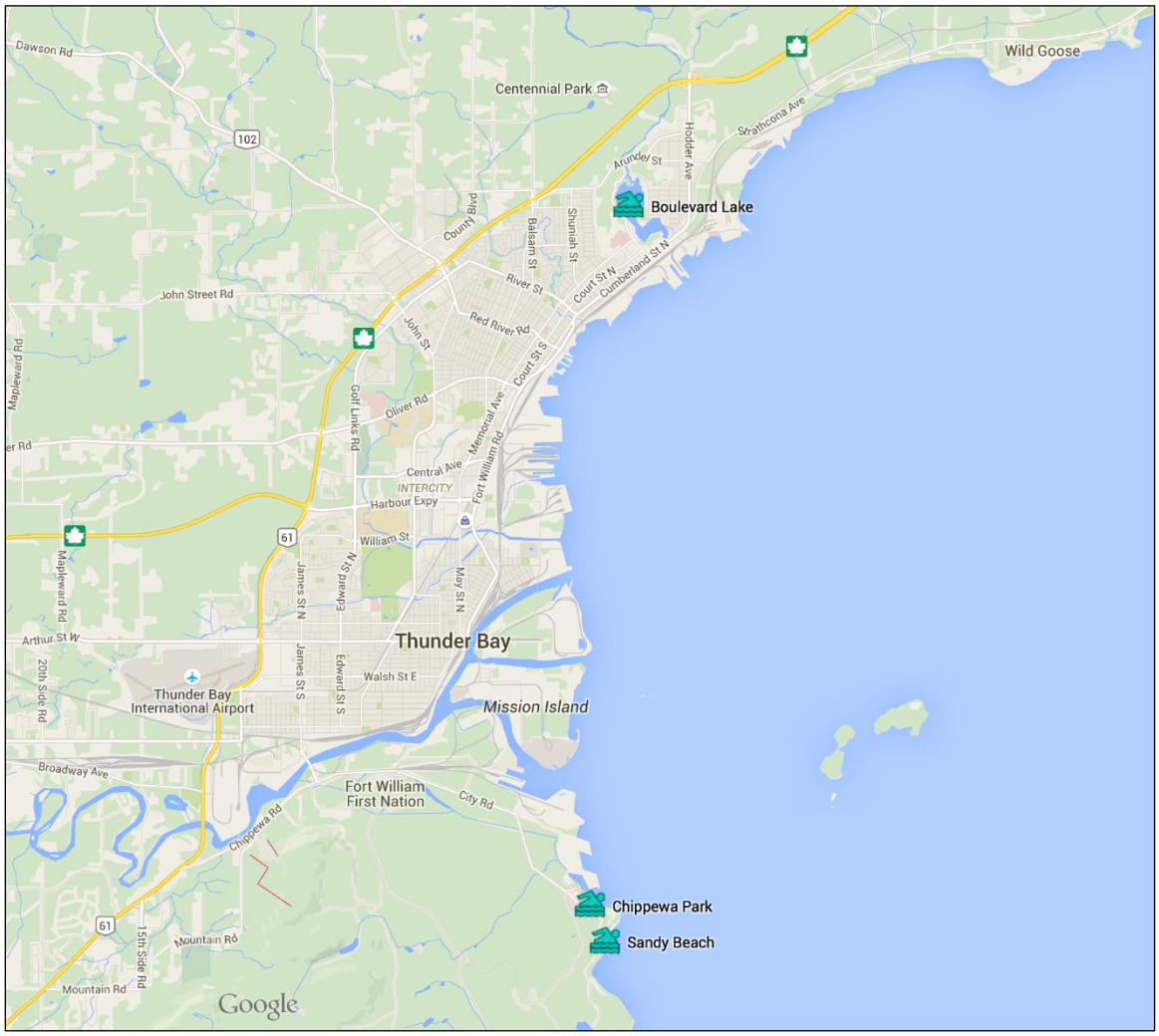

Figure 2: Map of Thunder Bay showing location of Chippewa Park and Boulevard Lake beaches

Chippewa Park

Chippewa Park, located on Lake Superior (Figure 3), was established as a park in 1921. It is currently owned and maintained by the City of Thunder Bay. In addition to the designated swimming areas at its two public beaches (Main Beach and Sandy Beach), Chippewa Park has an amusement park, RV campground and rental cabins, recreational sports fields and picnic areas,

and a wildlife exhibit that at one time was thought to be contributing to bacterial loading to the Main Beach.

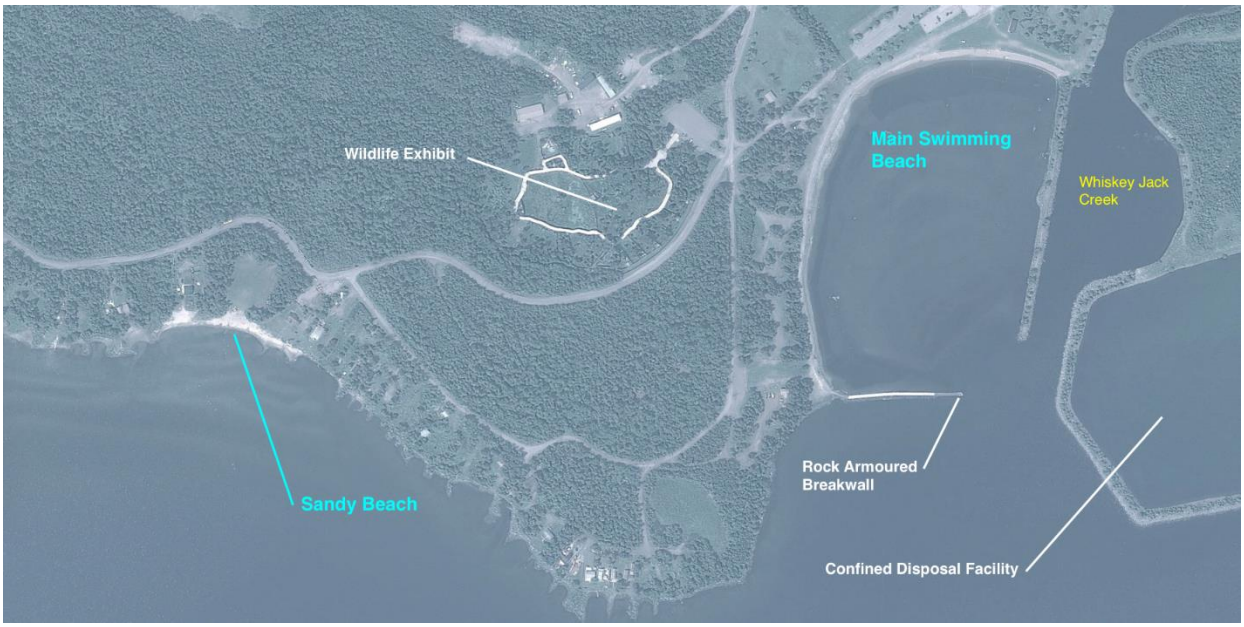

Figure 3: Location of Chippewa Park's Main Beach, nearby Sandy Beach, and key features of the area (Google Earth Attribute (Mapdata: Google and DigitalGlobe, 2015).

Chippewa Main Beach

Main Beach is located at the inshore end of a shallow lagoon (depth is less than two meters) that is open to the waters of Lake Superior through an opening approximately 90 meters wide. Between 2002 and 2003, the City of Thunder Bay built a rock pier and a rock-armored breakwall to help direct water flow from Whiskey Jack Creek and protect the swimming area from prevailing winds and waves of Lake Superior. During the same time, the City of Thunder Bay also removed a portion of the breakwall to increase water circulation, as stagnant flow had been a consequence of its earlier construction. There are community organizations, such as Friends of Chippewa Park, who advocate for the complete removal of the breakwall. This is a decision for the City of Thunder Bay, because it is the owner and manager of the property.

Chippewa Sandy Beach

Sandy Beach is 800 meters south of Main Beach via a walking trail and road, and it has full eastern exposure to the open waters of Lake Superior.

Boulevard Lake

Boulevard Lake is a constructed reservoir located within a popular park owned and maintained by the City of Thunder Bay (Figure 4). The lake is formed by a dam approximately 500 meters

upstream from Lake Superior, fed by the Current River. The maximum depth of the lake is 5 meters, the perimeter is 5.8 kilometers, and the surface area is 54 hectares (Proctor & Redfern, 1990).

Figure 4: Location of the three swimming beaches at Boulevard Lake (Sandy Cove, Lakeview, and Sunnyside). These correlate to historic TBDHU sampling locations.

The park is used recreationally for swimming, paddling, cycling, walking and running. Just outside the park, land use is institutional to the west, and residential to the east. Upstream land use along the Current River is recreational for several kilometers through a wide corridor of green space. Downstream land use is a mix of recreational, industrial and commercial. Historically, there are three public swimming beaches have been utilized at Boulevard Lake: Lakeview (or Main) Beach, Sandy Cove Beach, and Sunnyside Beach.

Boulevard Lakeview (or Main) Beach

Lakeview Beach is the main beach and public swimming location. This location is staffed with lifeguards and consists of a beach, playground, field, change room/washroom facilities, a mini-

golf course, a refreshment area and picnic areas. TBDHU continues to oversee beach advisories at this location.

Boulevard Sandy Cove Beach

Sandy Cove Beach is located on the western portion of the lake north of Lakeview Beach. A parking lot is located in this area and access to the beach is by way of a staircase going down a steeply sloped embankment. Sampling discontinued at Sandy Cove Beach in 2014, and TBDHU no longer oversees beach advisories at this location – see below.

Boulevard Sunnyside Beach

This beach is close to a parking lot, walking trails, picnic tables, a public washroom, and portable toilets. This beach is the closest to the residential areas to the east of Boulevard Lake (Conestoga-Rovers, 2009). Sampling discontinued at Sunnyside Beach in 2014, and TBDHU no longer oversees beach advisories at this location – see below.

MONITORING SCOPE

TBDHU has been and will continue to collect samples from the two beaches at Chippewa Park. At Boulevard Lake, sampling was discontinued at Sandy Cove Beach and Sunnyside Beach following the 2013 beach season, because TBDHU concluded that Sandy Cove and Sunnyside never truly met the definition of a public beach and the location of both beaches are more upstream from Lake Superior compared to the third Boulevard Lake Beach (Lakeview). Therefore, in consultation with the City of Thunder Bay, TBDHU officially and permanently removed Sandy Cove and Sunnyside as public beaches in 2015 and 2016, respectively. TBDHU's sampling at Boulevard Lake Main Beach continues.

While acknowledging these management decisions by TBDHU, this report documents the results derived from data collected at both Chippewa Park beaches (Main Beach and Sandy Beach) between 2005 and 2018, and it provides information on all three Boulevard Lake beaches (Main Beach, Sandy Cove Beach and Sunnyside Beach) where data is available. Again, note that only Lakeview/Main Beach from the three Boulevard Lake beaches continues to have monitoring in place by TBDHU.

Although monitoring results are provided for all beaches, Sandy Cove Beach and Sunnyside Beach will no longer be assessed in terms of the delisting criteria for the Beach Closings BUI.

MONITORING DATA – RESULTS

ASSESSMENT OF DELISTING CRITERION #2

Public Health Inspectors from the TBDHU sample for water quality at beaches supervised by the City of Thunder Bay on a weekly basis from the end of June to the end of August. As outlined above, the three beaches currently being monitored are: Main Beach and Sandy Beach at Chippewa Park, and Lakeview (Main Beach) at Boulevard Lake.

In the past, beach advisories were issued by TBDHU when monitoring data showed *E.coli* concentrations exceeded the former MOHLTC guideline of 100 *E.coli*/100mL of sample (geometric mean, minimum five samples). The advisory signage would be rescinded once samples proved to be non-adverse, or below the allowable *E.coli* count. TBDHU kept records of the total number of days a beach advisory was issued for all beaches per swimming season, including Sunnyside and Sandy Cove Boulevard Lake beaches, dating back to 2005.

The average duration of a beach season is approximately 70 days, and between 2005 and 2016, the average number of days on which advisories were issued, based on the ≤100 *E.coli* per 100mL guideline, are listed in Table 1 below.

Table 1: Average Number of Advisories Issued from 2005-2016 at Chippewa Park and Boulevard Lake Beaches based on the ≤100 *E.coli* per 100mL guideline

	Average Number of Days Advisory Posted between 2005-2016 (rounded to the nearest whole number)
Chippewa Main Beach	**30**
Chippewa Sandy Beach	**2**
Boulevard Lakeview Beach	**15**
Boulevard Sandy Cove Beach	**9 (2005-2013)**
Boulevard Sunnyside Beach	**24 (2005-2013)**

***** *In 2014, Chippewa Main Beach was permanently posted with a swimming advisory based on historical evidence of poor water quality. Note that starting in 2017, permanent advisories were issued at the beaches.*

The number of times an advisory was issued indicates the number of times, on average, the geometric mean of the samples collected exceeded the former provincial guideline of 100 *E.coli*/100mL of sample in a given season. Given that they are based on the former MOHLTC recreational water guideline, the average number of advisories presented in Table 1 are only meant to provide historical context (from 2005-2016) for beach conditions at Chippewa Park and Boulevard Lake beaches. The figures in Tables 1 are not meant for drawing comparisons against delisting criterion #2.

As of 2017, TBDHU discontinued issuing advisories at the three city beach locations based on adverse sampling because it was a poor reflection of current water conditions. Instead, TBDHU began to permanently post signage on Chippewa Park beaches and Boulevard Lake Main Beach (Lakeview) showing the percentage of time the water contained adverse, or above the limit levels of *E.coli*. The permanent advisory signs contain a percentage of water quality tests that indicates elevated levels of *E.coli* and are based on the average *E.coli* counts from the previous five years.

The new approach of permanent signage informs the public on the likelihood of the water containing elevated levels of *E.coli* based on occurrences in the past five years, and is therefore

more reflective of the probability of encountering high levels of *E.coli* on any given day. Figure 5 below is an example of a permanent advisory posted at Boulevard Lake Main Beach (Lakeview).

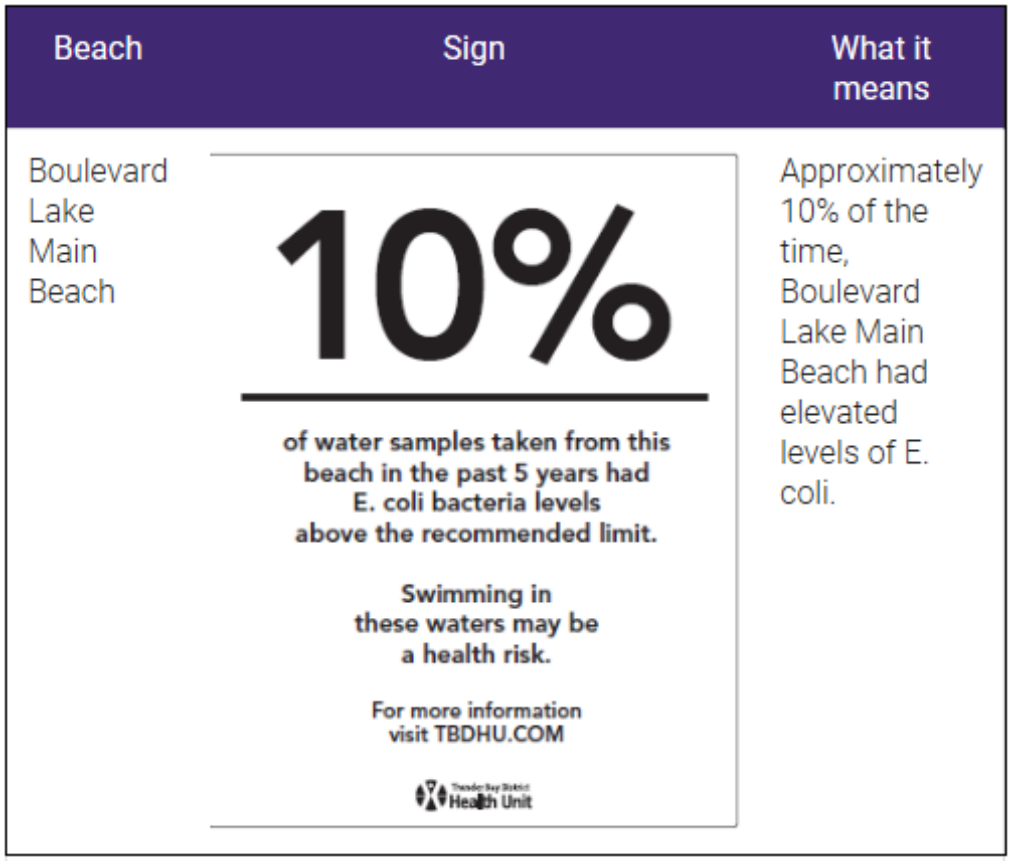

Figure 5: Sample of permanent advisory issued for Boulevard Lake Main Beach (TBDHU, 2018).

Given that TBDHU now posts permanent advisories at Chippewa Main, Chippewa Sandy and Boulevard Lakeview beaches, equivalency data to compare beach advisories (Table 1) under the revised MOHLTC guideline (≤200 *E.coli* per 100mL guideline) for 2017 onwards cannot be generated.

Beach advisories are still issued/rescinded outside the Thunder Bay city limits when monitoring indicates *E.coli* concentrations are "adverse" or exceed the provincial limit set by the MOHLTC. TBDHU continues to collect data at the Chippewa Main, Chippewa Sandy and Boulevard Main beaches for the purpose of monitoring. The following figures (Figure 6 – Figure 12) present data collected by TBDHU in an effort to draw conclusions on the state of the three beaches in Thunder Bay under the updated MOHLTC guideline of a geometric mean of ≤200 *E.coli*/100mL.

Average of Geometric Means at Chippewa Park and Boulevard Lake (2005-2018)

As mentioned on page 10, TBDHU collects a minimum of five samples from the beaches during weekly monitoring visits, and uses those samples to calculate the geometric means for each visit over the course of the entire beach season (end of June to end of August). In an attempt to show the general conditions at the beaches from 2005-2018, the averages of the geometric means were calculated per season and are shown below in Figures 6 and 7 for Chippewa Park and Boulevard Lake beaches, respectively.

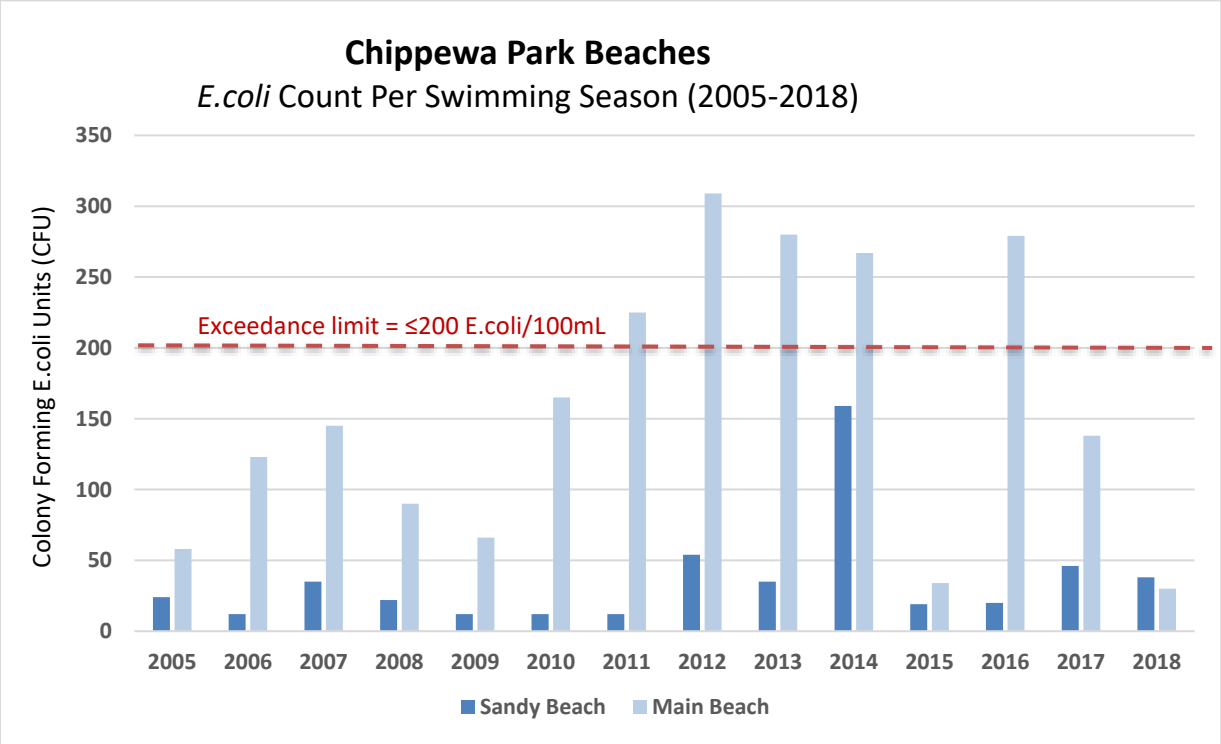

Figure 6: Average of *E.coli* Geometric Means at Chippewa Park Beaches: Main Beach and Sandy Beach from 2005 to 2018 (TBDHU, 2019).

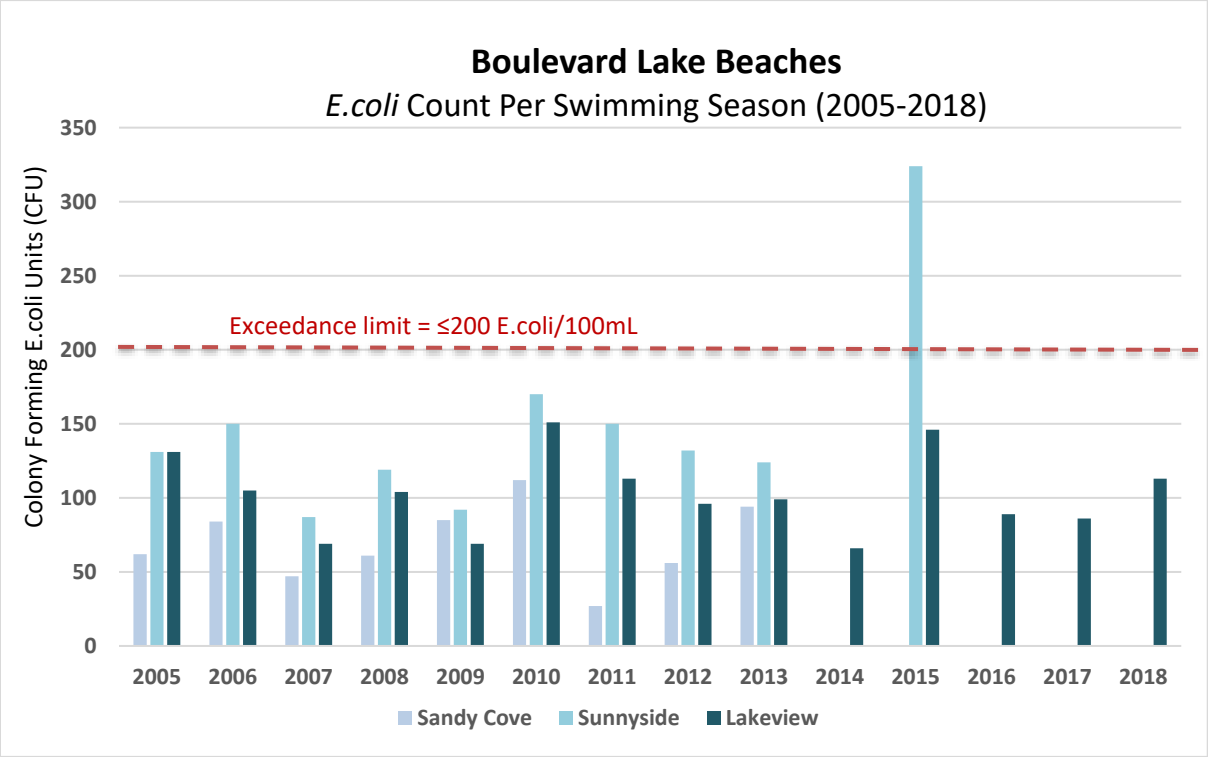

Figure 7: Average of *E.coli* Geometric Means at Boulevard Lake Beaches: Sandy Cove Beach, Sunnyside Beach and Lakeview Beach from 2005 to 2018 (TBDHU, 2019). ***Note:*** *Sampling discontinued at Sandy Cove and Sunnyside in 2014 since the beaches never truly qualified as public swimming beaches as per the original Public Beach definition. The MOHLTC changed the definition of a public beach in 2014, after which TBDHU started sampling at Sunnyside again but only for 2015. Sandy Cove and Sunnyside were both officially removed as public beaches in 2015 and 2016, respectively.*

As seen in Figures 6 and 7, the average counts of *E.coli* geometric means have remained below the 200 *E.coli*/100mL exceedance limit in recent years, with the exception of Chippewa Main Beach in 2016 (Figure 6) and Boulevard Sunnyside Beach in 2015 (Figure 7).

2018 Geometric Means at Chippewa Park and Boulevard Lake

To assess and compare *E.coli* levels against the updated provincial guideline, Figure 8 below shows the most recent *E.coli* geometric means for the 2018 beach season (July 3 to August 27) at Chippewa Main, Chippewa Sandy and Boulevard Lakeview beaches.

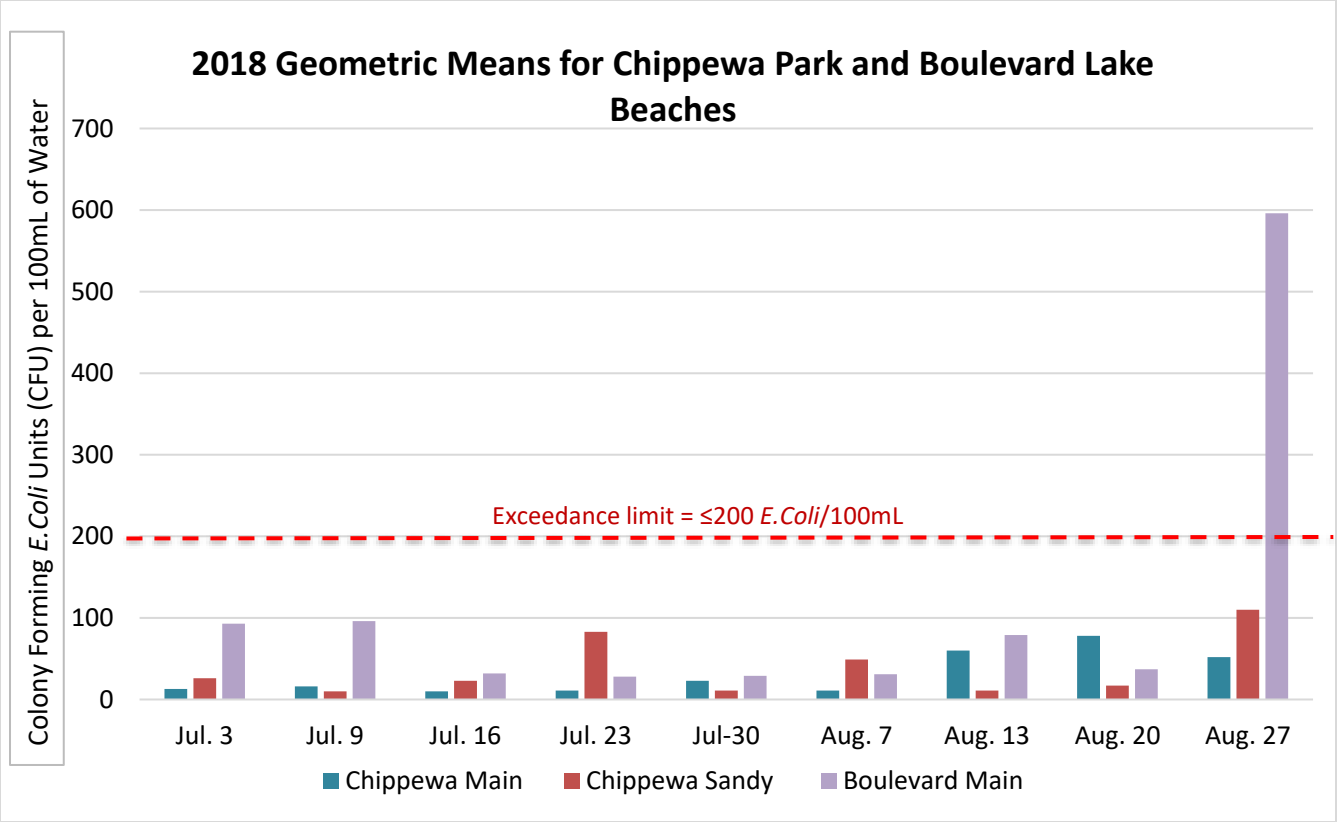

Figure 8: *E.coli* Geometric Means for Chippewa Main, Chippewa Sandy and Boulevard Main beaches during the 2018 Beach Season. ***Note:*** *The geometric means are calculated using a minimum of five samples for each weekly monitoring visit over the course of the beach season.*

As evidenced by the data in Figure 8, *E.coli* geometric means at Chippewa Main, Chippewa Sandy and Boulevard Main beaches have clearly remained below the new guideline of 200 *E.coli*/100mL over the course of the 2018 beach season, with the exception of August 27, 2018 when Boulevard Main Beach tested above the exceedance limit. August 27 was the last day the beaches were tested for the beach season in 2018.

Adverse Conditions at Chippewa Park and Boulevard Lake (2005-2018)

Figures 9 and 10 below show the percentage of adverse conditions at Chippewa Park and Boulevard Lake beaches from 2005-2018 as determined by the geometric mean of samples collected exceeding the threshold of 200 *E.coli*/100mL. In other words, the figures indicate the percent of samples collected each year that had a geometric mean in excess of 200 *E.coli*/100mL of sample.

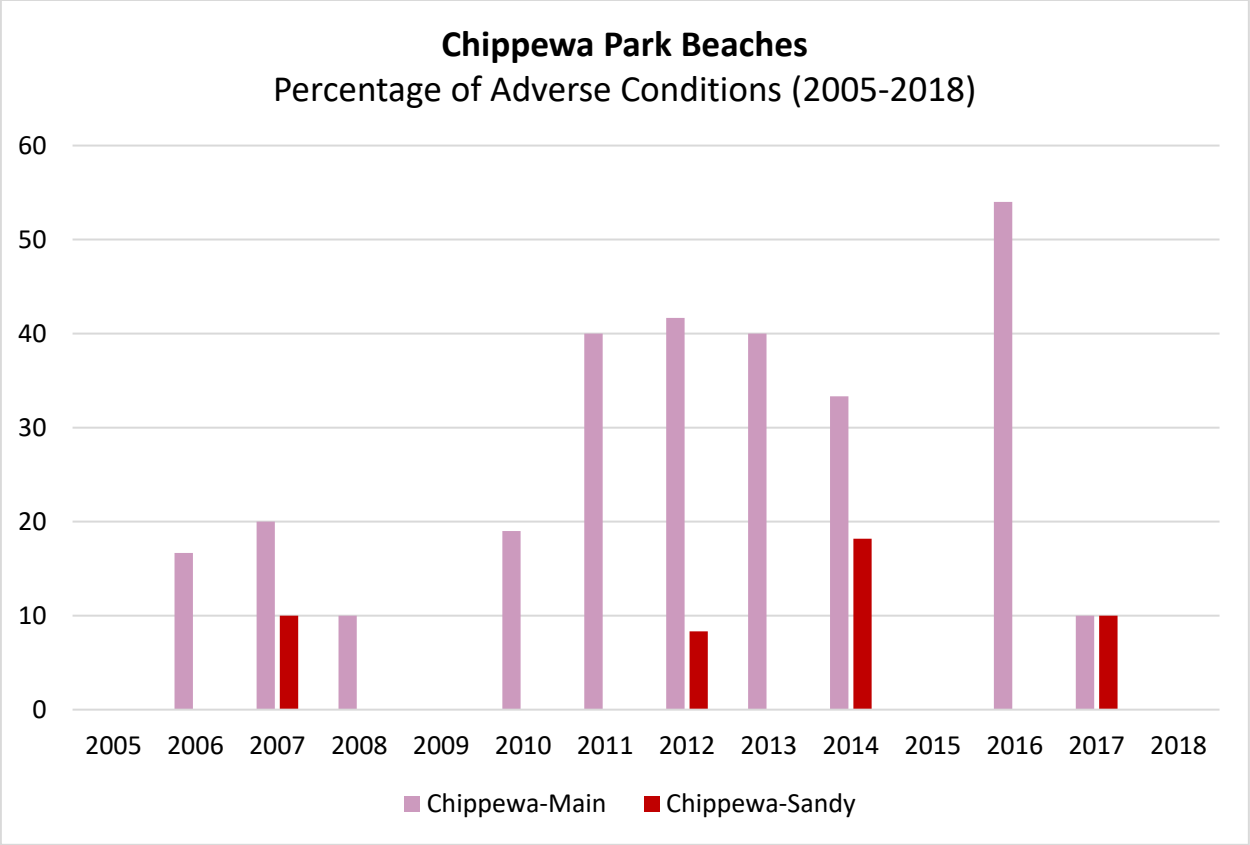

Figure 9: Percent of adverse conditions (geometric mean >200 *E.coli*/100mL sample) at Chippewa Park beaches from 2005-2018 (TBDHU, 2019).

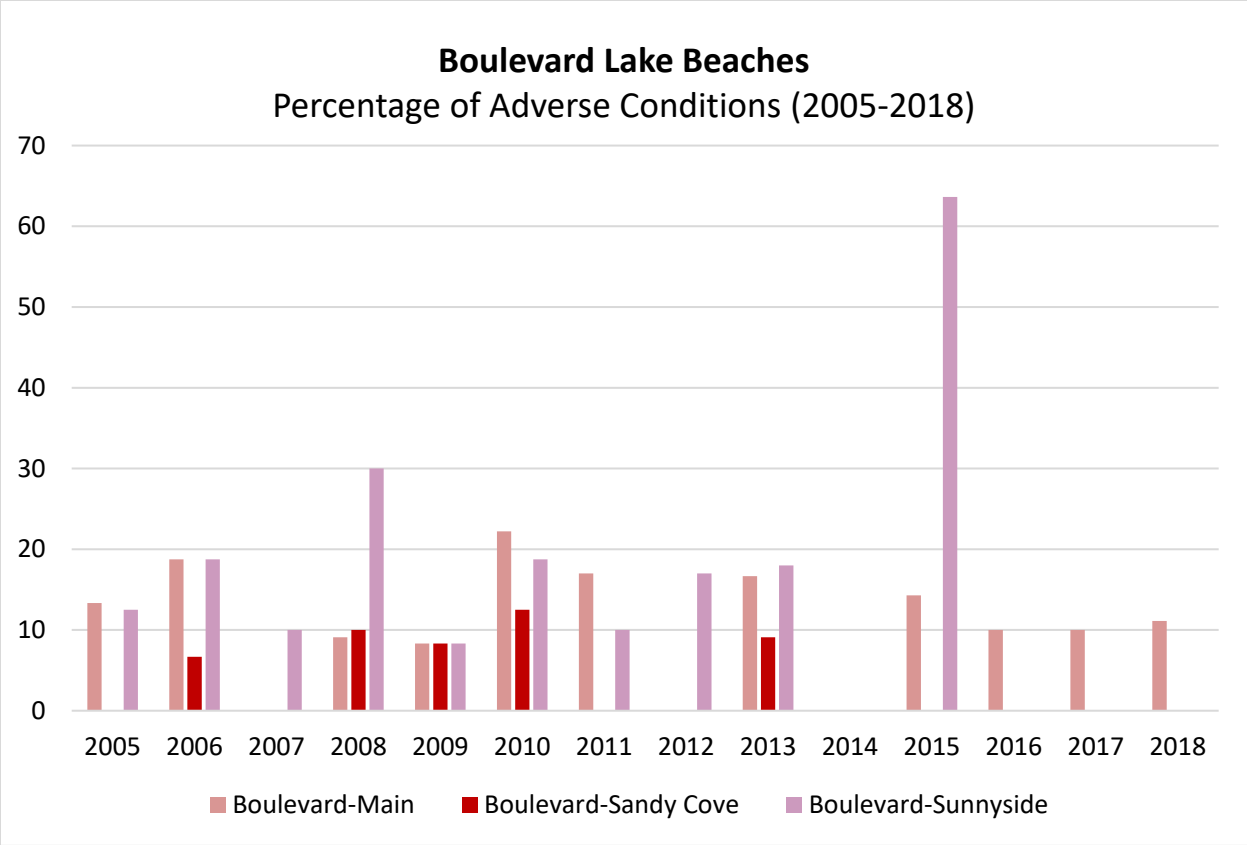

Figure 10: Percent of adverse conditions (geometric mean >200 *E.coli*/100mL sample) at Chippewa Park beaches from 2005-2018 (TBDHU, 2019). ***Note:*** *Sampling discontinued at Sandy Cove and Sunnyside in 2014 since the beaches never truly qualified as public swimming beaches as per the original Public Beach definition. The MOHLTC changed the definition of a public beach in 2014, after which TBDHU started sampling at Sunnyside again but only for 2015. Sandy Cove and Sunnyside were both officially removed as public beaches in 2015 and 2016, respectively.*

Note that both Chippewa Main Beach and Chippewa Sandy Beach (Figure 9) have not had any adverse conditions in 2018 (also evidenced by the data presented in Figure 8 above), and had very few adverse conditions in the year prior (10% for both Chippewa Main and Chippewa Sandy beaches in 2017). Clearly, the percentage of adverse conditions at Boulevard Main Beach (Lakeview) have also remained low over the years (Figure 10), with the highest being 22% in 2010.

Five-Year Monitoring Averages at Chippewa Park and Boulevard Lake

To assess the data presented so far in this report (Figure 6 through Figure 10) against delisting criterion #2, the five-year monitoring averages for Chippewa Main, Chippewa Sandy and Boulevard Main beaches were calculated and are presented in Figures 11 and 12 below. Figure 11 illustrates the five-year average from 2014 to 2018, and Figure 12 illustrates the five-year average from 2013 to 2017. The data are all based on the updated MOHLTC ≤200 *E.coli*/100mL guideline, and shows that percentage of adverse samples has dropped over the years at Boulevard Main Beach and Chippewa Main Beach.

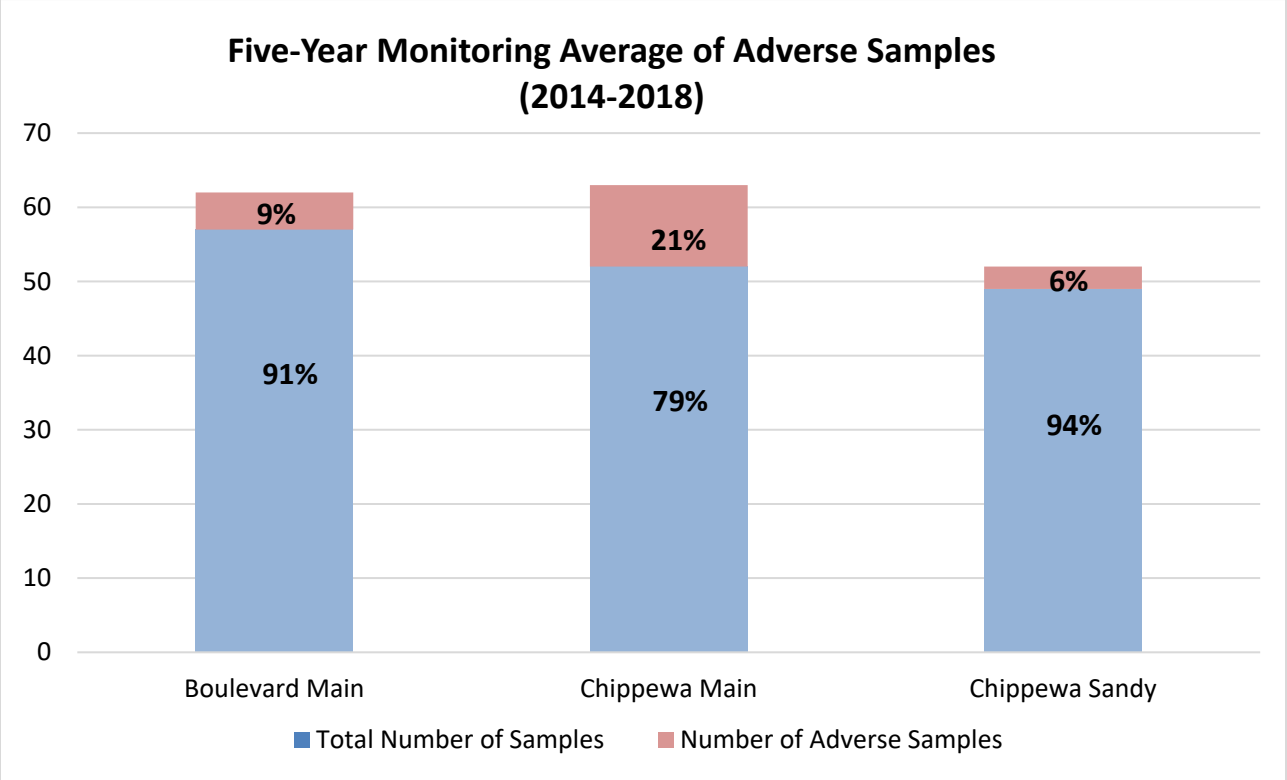

Figure 11: Percentage of adverse *E.coli* samples collected from 2014-2018 at Boulevard Main, Chippewa Main and Chippewa Sandy beaches (TBDHU, 2019). Note that the data is based on the updated MOHLTC guideline: ≤200 *E.coli*/100mL.

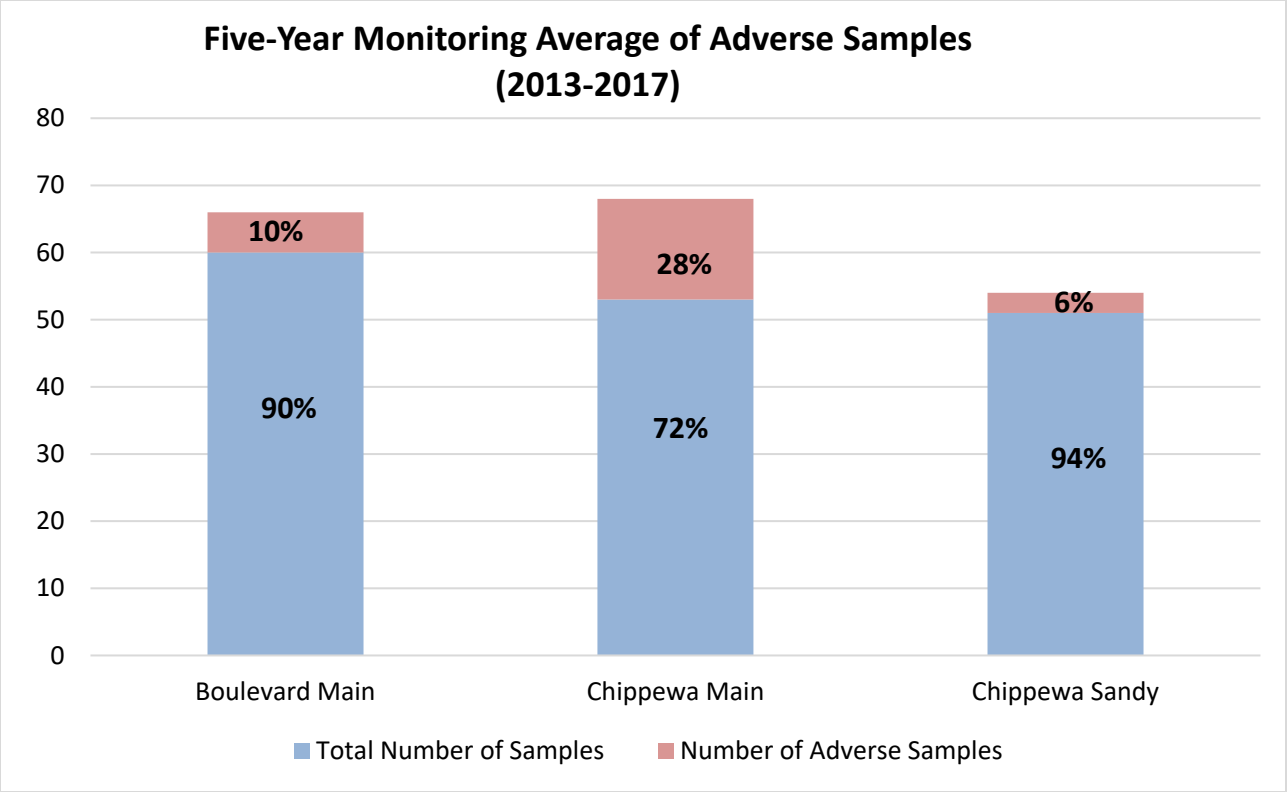

Figure 12: Percentage of adverse *E.coli* samples collected from 2013-2017 at Boulevard Main, Chippewa Main and Chippewa Sandy beaches (TBDHU, 2019). Note that the data is based on the update MOHLTC guideline: ≤200 *E.coli*/100mL.

Delisting criterion #2 states:

Water quality testing demonstrates that 80% of geometric means have E.coli counts of 200 or less colony forming units per 100mL of water (≤200 E.coli/100mL) based on a five year monitoring average.

Given the data presented in Figure 11 , the most recent five-year monitoring average from 2014-2018 demonstrates that 91% and 94% of the samples collected at Boulevard Main Beach and Chippewa Sandy Beach, respectively, had *E.coli* counts of ≤200 *E.coli*/100mL. Chippewa Main Beach is not far behind, with 79% of the samples tested as being under the new provincial limit. Note that Chippewa Main Beach was tested to have 0% adverse samples in 2018 (see Figures 8 and 9 above), and if the trend is maintained, this could result in an increased percentage of samples having *E.coli* counts of ≤200 *E.coli*/100mL at Chippewa Main Beach in the next iteration of the five-year monitoring average (2015-2019).

At present, water quality testing at Chippewa Sandy Beach and Boulevard Main Beach shows that 80% of geometric means have *E.coli* counts of 200 or less colony forming units per 100mL of water based on a five-year monitoring average, thereby meeting delisting criterion #2, with Chippewa Main Beach testing very close at 79%.

The five-year monitoring average for 2013-2017 (Figure 12) is also presented and it shows an improving trend towards meeting the delisting criterion at two of the three beaches. Samples containing ≤200 *E.coli*/100mL of water at Boulevard Main Beach improved from 90% in 2013-2017 to 91% in 2014-2018, at Chippewa Main from 72% in 2013-2017 to 79% in 2014-2018, and has remained the same at 94% at Chippewa Sandy.

Overall, data presented in Figures 6 through 12 show that under the new MOHLTC water quality guideline, water quality at Boulevard Main, Chippewa Main and Chippewa Sandy beaches is mostly meeting the delisting criteria of having ≤200 *E.coli*/100mL.

Over the years, management actions have been implemented to reduce bacterial contamination at the Chippewa Main, Chippewa Sandy and Boulevard Main beaches (refer to Completed Actions below), which help address the first component of the delisting criteria referring to the identification of *primary sources of fecal pollution*, and the development and implementation of *pollution control plans.*

Bacterial levels at the beaches in the past may be attributable to lower water flow rates in summer and stormwater discharge. The warmer water temperatures in the summer may also appeal to a larger crowd, ultimately leading to improper garbage disposal that attracts more waterfowl/animals that could increase fecal droppings in the water. Fecal coliform bacteria are the most common microbiological contaminants found in natural waters. They are excreted in the feces of warm-blooded animals, which includes humans.

Past studies at Chippewa Park indicate that local sources of feces, particularly from intestinal waste of waterfowl and other local animals that entered the bathing areas through stormwater runoff, were responsible for fecal coliforms at the beaches (Irwin, 1988). Each waterfowl dropping contained approximately 100 million fecal coliform bacteria, which were dispersed though wave action (Irwin, 1988).

Due to concerns raised by the public regarding potential human fecal contamination at beaches, Environment and Climate Change Canada commissioned a study in 2011 to determine whether human fecal contamination was a contributing factor to bacterial concentrations. The study, which is appended to this report (Appendix C), concluded that human fecal contamination was <u>not</u> contributing to beach postings at the Chippewa Park Main Beach, nor at Boulevard Lake Main Beach. The Paleo-DNA Laboratory at Lakehead University collected surface water samples from Chippewa and Boulevard beaches for genetic analysis in 2010, which conclusively determined that human fecal contamination was not a contributing factor of bacterial contamination at the beaches studied (Fratpietro, 2011). The genetic analysis revealed six DNA sequences from an animal source, potentially from six different animals or subspecies, and detected no human fecal bacteria markers (Fratpietro, 2011).There was no concern or possible sources and pathways for human bacteria to enter Chippewa Park Sandy Beach, thus this beach was not included in the study.

In addition to the conclusions drawn from the DNA analysis conducted in 2010, public health officials at TBDHU also expressed that human fecal contamination was not a contributing source of bacterial contamination at the beaches, stating:

"Thunder Bay District Health Unit recognizes the 2010 study conducted by Paleo-DNA Laboratory at Lakehead University, which found that human faeces is not a significant contributor to bacterial contamination of beaches in the Thunder Bay AOC. While we do not have the expertise to comment on the methods utilized in that study, we have no reason to dispute the specific findings or the conclusions. Our own observations suggest that the vast majority of visually-observable faeces on beaches in the Thunder Bay AOC appears to be from geese" (TBDHU, Personal Communication, 2019).

Management of waterfowl and other animals for the purpose of reducing or eliminating fecal droppings at the Thunder Bay public beaches falls under the jurisdiction of the City of Thunder Bay.

Comparisons Against Single-Sample Max Exceedance of 400 *E.coli* per 100mL

Although not adopted in the delisting criteria, the 2018 revision of the Recreational Water Protocol introduced an additional element to the MOHLTC guideline for recreational water use at public beaches. This new element addresses the maximum value allowed in a single-sample collected, whereby a single-sample maximum concentration must be ≤400 *E.coli* per 100mL of sample to meet the water quality test (MOHLTC, 2018b). The MOHLTC protocol therefore suggests in order for the water quality at beaches to be acceptable, the geometric mean must be ≤200 *E.coli*/100mL of sample, and have a single-sample maximum concentration ≤400 *E.coli*/100mL of water. Both of these elements are consistent with Health Canada's recreational water guidelines for the whole country.

Although the single-sample maximum is not part of the delisting criteria for Thunder Bay AOC, it can still inform the current state of the Beach Closings BUI. Data presented in this report was measured solely against the first element of the MOHLTC guideline, which is that the geometric mean of a minimum of five samples must be ≤200 E.coli/100mL of sample. However, should the single-sample maximum be considered in concert with the geometric mean, it is worth noting that the data would have had only three additional adverse samples as a result of a single-sample exceedance of 400 *E.coli*/100mL between 2011 and 2018. Two additional adverse samples were collected at Boulevard Sunnyside Beach (one in 2012 and one in 2013), and the third collected at Chippewa Main Beach in 2016.

Boulevard Sunnyside Beach is no longer evaluated under the RAP delisting criteria because it was closed as a public beach by the TBDHU after discussions with the City of Thunder Bay. For Chippewa Main Beach, the additional adverse sample collected in 2016 due to a single-sample exceedance can be considered in the context of Figure 11, which presents the five-year

monitoring averages from 2014-2018. Figure 11 shows that 79% of the samples tested at Chippewa Main were adverse when measured against the geometric guideline of ≤200 *E.coli*/100mL. By considering the single-sample adverse sample collected in 2016, the five-year monitoring average for Chippewa Main Beach would be 77%. In both cases, Chippewa Main is very close to meeting the delisting criterion of having geometric means that have ≤200 *E.coli*/100mL 80% of the time.

The five-year monitoring averages for both Chippewa Sandy and Boulevard Main beaches remain unaffected by the single-sample exceedance of 400 *E.coli*/100mL.

Individual sample results are not available from 2005 to 2010.

COMPLETED & ONGOING ACTIONS

ASSESSMENT OF DELISTING CRITERION #1

The Stage 2 RAP report identifies water use goals to assist in the rehabilitation of the Beach Closings BUI (refer to Table 2 below). The Public Advisory Committee, in combination with available scientific data and expertise, developed these goals based on community guidelines to help further reduce and mitigate bacterial contamination at the public beaches. The Stage 2 RAP report further identified remedial strategies to meet these water use goals, which consisted of two general recommendations for implementation through specific remedial actions or projects. These remedial actions focus on controlling or eliminating the underlying disruptive factors that caused the historical impairment. The recommendations listed in the Stage 2 RAP report were combined for the Degradation of Aesthetics and Beach Closings BUIs and are listed below in Table 2.

Remedial actions undertaken in response to the recommendations listed in the Stage 2 RAP report were identified in the 2009-2012 Thunder Bay RAP Update report, and are also listed in Table 2.

Table 2: Remedial Actions Recommended for the Beach Closings BUI for the Thunder Bay Area of Concern.

2004 Thunder Bay Stage 2 RAP Report	**Water Use Goals for Beach Closings BUI:** • Recreational bathing, fishing and boating should be attractive to the public and pose no human health risk. • Natural Values within the AOC should be accessible and attractive to the public. **Remedial Strategies:** • **Recommendation 3-1:** Implement aesthetic improvements to the Thunder Bay harbour and its tributaries to promote access and allow for passive recreational activities. o ***Action ES-1:*** *Community Cleanup of the Thunder Bay Waterfront* • **Recommendation 3-2:** Ensure that point and non-point source effluent and waterfront development does not have an adverse effect on aesthetic appreciation or recreational pursuits within the AOC. o ***Action NPS-3:*** *Improvements at Chippewa* o ***Action NPSM-3:*** *Monitoring Contamination and Potential Sources in the Main Swimming Areas*
2012 Thunder Bay RAP Update Report	**Remedial Actions Undertaken:** • **SM-BA-1:** Stormwater Impacts Assessment *(Ongoing Assessment Initiative – 2010 & 2011)* • **SM-BA-2:** Beach Bacteria DNA Analysis *(Completed Monitoring Initiative - 2010)* • **SM-BA-3:** Chippewa Beach Advisories – Review & Analysis *(Completed Monitoring Initiative - 2012)*

Management at both Chippewa Park and Boulevard Lake has continued over the years to implement the recommended remedial measures through a combined effort of several agencies, led by the City of Thunder Bay with federal and provincial funding support, and the TBDHU. The following is a list of all management actions implemented in the AOC pertaining to the Beach Closings BUI as identified in the Stage 2 RAP report (1991), the RAP Update report (2012), and the Analysis report prepared by the Lakehead University Remedial Action Plan Office (2012) appended to this report (Appendix B).

Chippewa Park Beaches

Before 1996

- Even before the Thunder Bay RAP was developed, remedial measures at Chippewa Park began in the late 1980s to address periodic bacterial contamination leading to unsuitable swimming conditions during the summer months.
- Based on the sources of contamination identified in Irwin's studies released in 1986 and 1989, commissioned by the Ministry of the Environment, Conservation and Parks, the City of Thunder Bay completed a considerable amount of work in an attempt to reduce bacterial contamination at Chippewa Park, including:
    - Installation of weeping tile and drainage ditching to improve drainage
    - Culvert replacement to allow for improved water flow to the beach area
    - Installation of a new septic field for public washrooms located near the beach
- Between 1993 and 1997, improvements to wastewater treatment at local pulp and paper mills were implemented by local industries in response to provincial and federal wastewater regulations.

1996 – 2004

- In 1996, the consulting firm Engineering Northwest was hired to investigate potential remedial options that would help reduce bacterial problems at Chippewa Park. From the report, preferred strategies were selected and implemented by the City of Thunder Bay. The final cost for the beach rehabilitation was in the range of $750,000 (Lakehead University, 2012) and included the following remedial actions:
    - Drainage system upgrades to divert surface and groundwater drainage away from the main swimming area
    - Re-grading of Main Beach to re-direct stormwater runoff
    - Sediment removal post-dredging in 2003
    - Partial removal of breakwall to increase water circulation in 2002 and 2003

2005 -2009

- The City of Thunder Bay:
    - Implemented a program to reduce presence of waterfowl using hazing and egg depredation, and removal of the band shell from the area
    - Implemented secondary treatment at the Water Pollution Control Plant in 2005, with ultra-violet disinfection added in 2006. The cost of the secondary upgrade was $73.6 million (Vander Wal et al., 2004).

2010 – Present and Future Considerations

- RV park septic system upgrade by the City of Thunder Bay at the Chippewa Mobile trailer park in 2011
- Grass grooming/raking program implemented by the City of Thunder Bay Parks Department at Chippewa Main Beach to remove goose droppings

- In 2010 and 2011, Lakehead University carried out a stormwater impact assessment on three AOC waterways discharging to Lake Superior: McVicar Creek, Lower Neebing River, and Lyons/Third Avenue Channels. Results show a correlation between the quality of stormwater discharge and urban landuse inputs found within the sub-watershed.
- In 2011, the Fratpietro study commissioned by Environment and Climate Change Canada concluded human fecal contamination is not contributing to beach postings at the Chippewa Park nor Boulevard Lake Main beaches
- In 2012, the Remedial Action Plan Implementation Committee and Lakehead University completed the Review and Analysis for Chippewa Beach advisories (Appendix B)
- In December 2016, the Government of Canada reached a land claim settlement with Fort William First Nation for an area north of the reserve and southward near Loch Lomond Road, as well as Chippewa Main Beach and Sandy Beach
- In June 2017, the City of Thunder Bay announced that the Visioning Exercise for Chippewa Park is currently on hold due to consultations with Fort William First Nation. The project will explore opportunities to improve the park's recreational and cultural resources.
- In the case of Chippewa Main beach, the RAP Coordinating Committee shall continue to use the data provided by TBDHU to track and review annual *E.coli* levels to evaluate when the MOHLTC guideline of ≤200 CFU/100 mL and BUI delisting criterion #2 is achieved.
- As the land owner and manager, the City of Thunder Bay may consider:
    - Whether to expand on the partial breakwall removal in 2002-2003 and review whether to implement the selected option from the 2015 Chippewa breakwall study, which was to create a hole in the breakwall to allow for greater circulation.
    - Working with local agencies to determine the feasibility of Low Impact Development (LIDs) as to not further degrade the environment even though bacteria levels may not decrease.
    - Reviewing the success of the beachfront grooming programs to determine whether grooming plays an integral role in improving the water quality during beach season.
    - Continuing with beach cleaning program (i.e. the hazing and egg depredation program) to manage waterfowl impacts at the beach and ensure it is included in future maintenance plans. Determine if a program aimed at deterring Canada Geese and Herring Gulls from roosting at Chippewa Park is required in addition to the grooming.
    - Completing the Visioning Exercise announced in June 2017 intended to explore opportunities to improve the park's recreational and cultural resources.

Boulevard Lake Beaches

1990s

- Between 1993 and 1997, the improvements to wastewater treatment at local pulp and paper mills were implemented by local industries in response to provincial and federal wastewater regulations.

2005

- The City of Thunder Bay implemented secondary treatment at the Water Pollution Control Plant in 2005, with ultra-violet disinfection added in 2006. The cost of the secondary upgrade was $73.6 million (Vander Wal et al., 2004).

2010

- In 2010 and 2011, Lakehead University carried out a stormwater impact assessment on three AOC waterways discharging to Lake Superior: McVicar Creek, Lower Neebing River, and Lyons/Third Avenue Channels. Results show a correlation between the quality of stormwater discharge and urban landuse inputs found within the sub-watershed.

2011

- The Fratpietro study commissioned by Environment and Climate Change Canada concluded human fecal contamination is not contributing to beach postings at the Chippewa Park nor Boulevard Lake Main beaches

2012

- A study completed by Jeremy Yang assessing sources of *E.coli* in Boulevard Lake during summer 2011 aside from stormwater outfalls or geese concluded the primary *E.coli* source was from the lake bottom periphytic community. Periphytic community refers to the "collection of organisms, such as algae and bacteria, that live on the surface of submerged plants and other underwater objects" (Yang, 2012)

2015

- Stormwater Management Master Plan finalized by City of Thunder Bay. Intent of the Plan is to identify methods for reducing stormwater runoff throughout the City and its watershed. Boulevard Lake is part of the Current River watershed, which has been identified with over 83 Best Management Practices (BMPs) locations, of which, approximately 20 surround the lake itself. Practices for the lake include mostly biofiltration, and one location for impervious surface removal (City of Thunder Bay, 2016).

2016

- In May 2016, the City of Thunder Bay completed a Visioning Exercise (also known as the Park Master Plan) documenting its consultation with the public for recommendations for the future use and maintenance of Boulevard Lake Park, including improvements in the lake's water quality. The recommendations contained within the master plan have

been put on hold pending the results of the municipal environmental assessment for the reconstruction of the Boulevard Lake Dam.

2019

- In January 2019, the City of Thunder Bay announced that it has allocated nearly $7 million under its 2019 budget for the reconstruction of Boulevard Lake Dam. Reconstruction is set to begin in 2020.

Future Considerations

- The City of Thunder Bay may:
    - Complete the Visioning Exercise that may assist in establishing a timeline and priority options for implementing the approximately 20 best management practices identified in the City's 2016 Stormwater Management Master Plan.
    - Implement beach cleaning/grooming program at Boulevard Lake and, if it is successful, ensure it is included in future maintenance plans. Review the success of the beachfront grooming to determine whether grooming plays an integral role in improving the water quality during beach season.
    - Determine if a program aimed at deterring Canada Geese and Herring Gulls from roosting at Boulevard Lake is required in addition to the grooming.

COMPARISON AGAINST DELISTING CRITERIA

Table 3 below provides a breakdown of the different components for the Beach Closings BUI delisting criteria at the Thunder Bay AOC, and identifies the remedial actions completed (in green) or still pending (in red) for each. The delisting criteria for the Beach Closings BUI is:

- *All public beaches have identified primary sources of fecal pollution and pollution control plans have been developed and implemented, including:*
    - *Management of stormwater inputs*
    - *Upgrades of septic systems to provincial standards*
    - *Implementation of a management program for birds and animals*
    - *A completion of feasible actions to improve water circulation*

- *Water quality testing carried out at all public beaches on a regular, frequent and ongoing basis demonstrates that 80% of geometric means have E.coli counts of 200 or less colony forming units per 100mL of water (MOHLTC, 2018b) based on a five year monitoring average.*

Table 3: Thunder Bay PAC Beach Closings BUI Delisting Criteria versus completed Remedial Actions as identified in the Stage 2 RAP report, the RAP Update report and the Review and Analysis of Chippewa Advisories prepared by Lakehead University.

Delisting Criteria	Chippewa Main Beach	Chippewa Sandy Beach	Boulevard Lake
1. a) Identified primary sources of fecal pollution	2011 Fratpietro DNA Study concluded that human fecal matter is not a contributing factor.	Not applicable.	2011 Fratpietro DNA Study concluded that human fecal matter is not a contributing factor.
1. b) Pollution control plans have been developed	-Alternatives to improve water quality developed in 1996 by Engineering Northwest the City of Thunder Bay.	-No current plans in place.	- City of Thunder Bay's Stormwater Management Plan (2016). See 1d below.
1. c) Pollution control plans have been implemented	-Band shell removed (2009); however, underwater rock berm is now being used as a perch (2012).	-No current plans in place.	- City of Thunder Bay's Stormwater Management Plan developed providing recommendations on non-point source control, overflow control and monitoring (2016). See 1d below.
1. d) Management of Stormwater Inputs	-Not identified in City of Thunder Bay's 2016 Stormwater Management Plan.	-Not identified in City of Thunder Bay's 2016 Stormwater Management Plan.	-2016: ~20 best management practices identified, which include biofiltration and impervious removal.
1. e) Upgrades to septic systems to provincial standards	-Installation of new septic field for beach & amusement park (1996). - RV park septic system upgraded (2011). -Ontario Drinking Water Stewardship Program provides funding to prevent runoff and erosion and protect municipal drinking water supplies.	Not applicable.	Not applicable.
1. f) Bird & animal management plan	-Bird hazing & egg depredation implemented by the City of Thunder Bay (2007-2011) -Falcon deterrent program implemented by the city of Thunder Bay, which was unsuccessful.	No current plans – may be listed in Chippewa Park Master Plan.	No current plans – may be listed in Boulevard Lake Park Master Plan.
1. g) Completion of feasible water circulation improvements	-Partial breakwall removal by the City of Thunder Bay (2002-2003)	Not applicable.	Not applicable.

2. Regular water quality testing (80% of *E.coli* counts of 200 or less colony forming units per 100ml of water based on a 5 year monitoring average	-Beach currently does not meet the 80% requirement between 2014-2018, as it is 79%	-Beach currently meets the 80% requirement between 2014-2018, as it is 94%.	-Lakeview/Main Beach currently meets the 80% requirement between 2014-2018, as it is 91%.

Data presented in Figure 10 provide evidence that the second criterion is very close to being met. Routine sampling at Chippewa Sandy Beach and Boulevard Main Beach show *E.coli* counts of ≤200 E.coli/100mL of water over 90% of the time over the 5-year average between 2014 and 2018. Chippewa Main is the only beach that currently has not yet met the criteria, with only 79% of the samples tested meeting the new provincial limit for the same 5-year period 2014-2018.

CONCLUSION

Even before the Areas of Concern program was established in the late 1980s, there were investigations into the potential sources of bacterial contamination affecting beaches in Thunder Bay. A study by Irwin in 1986 (later confirmed with a follow-up study in 1989) attributed elevated levels of fecal coliform bacteria in bathing areas to stormwater runoff and waterfowl fecal wastes. In 2011, Fratpietro conducted a genetic analysis of water quality samples, testing *E.coli* for human and fecal bacteria markers. The study identified six different animal sources of animal subspecies as contributing to bacterial contamination, further reinforcing Irwin's conclusions, and affirmed human fecal bacteria is not detected at Chippewa Park and Boulevard Lake Main beaches.

As evidenced by a number of completed remedial actions, efforts to reduce pollutants and contaminants entering beaches have been implemented from the mid-1990s to current times.

Further to the first part of the delisting criteria (i.e., *Identifying primary sources of fecal pollution, and implementing pollution control plans),* knowing that human fecal contamination is not a contributing factor to beach postings, the management of waterfowl, which has been identified as the source of bacterial pollution, could be a matter best addressed by on-going efforts by the City of Thunder Bay. And given that two of the three public beaches under consideration are within the provincial recreational water quality guideline and the third is very close, and that the number of adverse samples at the third beach (Chippewa Main) are showing a declining trend, it will be appropriate to discuss the costs and benefits of taking further action, including that to further improve water quality circulation at Chippewa Park. Past efforts and investments that have already improved the water circulation should be acknowledged.

Overall, the results presented in this report show that Chippewa Sandy and Boulevard Main beaches meet the second part of the Beach Closings BUI delisting criteria (i.e., *five-year monitoring average of geometric mean E.coli bacteria at a count of 200 or less colony forming*

units per 100mL of water 80% of the time). The Chippewa Main Beach is showing a declining trend and is just short of meeting the target. With respect to the second element of the MOHLTC guideline introduced under the Recreational Water Protocol in 2018, results show that only three additional adverse single-samples tested in 2018 were found to exceed the maximum concentration of 400 *E.coli* per 100mL.

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APPENDIX

A: Literature Review by Kaegan Walsh (June, 2011)

B: Review and Analysis of Chippewa Beach Advisories by Lakehead University RAP Office (June, 2012)

C: Paleo-DNA Analysis, Fratpietro Study (January 2011)